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MINING AND MILLING OPERATIONS OF RUTILE MINE OF THE TITANIUM ALLOY CO. OF ARKANSAS HOT SPRING COUNTY, ARK.

BY

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MINING AND MILLING OPERATIONS OF THE RUTILE MINE OF THE TITANIUM ALLOY CO. OF ARKANSAS, HOT SPRING COUNTY, ARK. [1]

By Felix A. Vogel, Jr. [2]

SUMMARY

Rutile concentrate, used in the manufacture of welding rods, smoke-screen chemicals, and alloys, is being produced by the Titanium Alloy Co. of Arkansas at its mine and mill in Magnet Cove. The company estimates a substantial reserve of recoverable rutile. This is a new operation, and production figures are not known. Previous operations had stripped the placer material, leaving the underlying mineralized zone.

INTRODUCTION

This report describes the mining and milling operations of the Titanium Alloy Co. of Arkansas. The property was examined by the author on March 4, 1942, and subsequent dates. J. A. Wood, general manager, was very helpful in supplying information.

The operations of the Titanium Alloy Co. of Arkansas are north of Cove Creek in Magnet Cove and near the middle of the northeastern part of Hot Spring County, Ark.

A private road leads southwest 1 mile from the property to U. S. Highway No. 27, running east and west. From this point on the highway Hot Springs is about 12 miles west, and Magnet (a small hamlet on the rim of the cove), 2.7 miles east. The rutile concentrate is hauled about 6 miles by truck from the plant through Magnet to Butterfield on the Chicago, Rock Island, & Pacific Railroad.

The property is owned and operated by the Titanium Alloy of Arkansas, Malvern, Ark. This company is a subsidiary of the Titanium Alloy Manufacturing Co. of New York, with headquarters at 111 Broadway, New York, and a manufacturing plant at Niagara Falls.

Part of the property is owned in fee, and part is leased. With the exception of two parcels, the property is in the central parts of secs. 17 and 18, T. 3S., R. 17 W. The main ore body, known as the Perkins, which is now being developed, is in the east center of section 18.

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[1] The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7293."

[2] Mining engineer, Bureau of Mines.

The land containing the Perkins ore body covers 306 acres and is leased from J. E. Rutherford. The company also owns land in the SE$\frac{1}{4}$ SE$\frac{1}{4}$, sec. 13, T. 3 S., R. 18 W., and the NW$\frac{1}{4}$ NW$\frac{1}{4}$, sec. 19, T. 3 S., R. 17 W.

PHYSICAL FEATURES

The Magnet Cove district lies in the Interior Highlands physiographi province bordering the Gulf Coastal Plain. Magnet Cove is an elliptical, basinlike depression surrounded by rim rock. The average elevation in th basin is 350 feet and the relief about 100 feet.

Cove Creek drains Magnet Cove in a southerly direction, having cut through the rim rock on both the northeast and south sides of the cove. The rutile mine is on the flood plain of this creek in the northern part of the basin. Cove Creek empties into the Ouachita River.

The average annual rainfall is 47 inches and the average temperatur 61°. Except during occasional periods of excessive rainfall, work can be carried on throughout the year. The basin is devoted to farming, and lit timber remains. However, there is an ample supply of timber for mining purposes in the surrounding country.

HISTORY

Magnet Cove has long been known as a source of rare minerals. The widespread occurrence of titanium in various minerals found at this locality has been known since 1890, but mining is comparatively recent.

Prospecting for rutile by auger drill was begun in 1912 or 1913. At the same time a shaft was sunk to a depth of 81 feet, and several drifts were driven on the property now operated by the Titanium Alloy Co. of Ark sas. Also, an adit was driven 200 feet into a brookite deposit in Chamb Creek gorge on the east side of the cove. This deposit is now undergoing development.

The first successful mining of rutile in Arkansas was begun by the Titanium Corporation of America in 1932 at the locality now being worked. Mining and milling operations were confined to the oxidized zone.

This operation continued until the Titanium Alloy Co. of Arkansas purchased the property in 1942. The latter company explored the ore in place underlying a portion of the oxidized zone, built a new concentratin plant, and made some preliminary runs. Extensive alterations, including a change from gas to electric power and the installation of a water pipe line, were indicated and have recently been completed.

PRODUCTION

Most of the output of the Titanium Corporation of America from 193 to 1942 was sold abroad. No records of this operation are available, oth that the capacity of the mill was 30 to 40 tons of ore an hour and that t output was 200 to 600 tons of concentrate a year. The concentrate was marketed as brookite, which is a misnomer, as the mineral is rutile.

The new owners have not operated the property long enough to obtain records of annual production. In November and December 1942 and January 1943 about 80 tons of metallurgical-grade concentrate was produced by reconcentrating the rejected portion from the magnetic concentrator used by the former owners. Production from ore in March 1943 was 60 tons of metallurgical-grade concentrate and 20 tons of welding-grade. Metallurgical-grade material contained 85 to 90 percent TiO_2 and less than 0.6 percent P_2O_5, while welding-grade contained 95 percent TiO_2. At present, only one grade of concentrate (plus 90 percent TiO_2) is being produced. The company hopes to attain a production of 150 tons of this concentrate monthly.

ORE DEPOSTIS

Magnet Cove is an igneous massif composed of genetically related nepheline syenites and associated basic dikes which have intruded the overlying Paleozoic sediments. The floor of the basin is covered with residual and transported soils, especially in the locality under consideration. Stripping of some of this material during mining operations has exposed the underlying formations, the geology of which is complicated.

These formations appear to be greatly altered remnants of tinguaitic and monchiquitic dikelike masses. Alteration was due to hydrothermal metamorphism and weathering.

Titanium occurs in Magnet Cove in both amorphous and crystalline form. as a constituent of many different rocks and as individual crystals. The most important titanium-bearing minerals include: Rutile (TiO_2), brookite (TiO_2), octahedrite (TiO_2), ilmenite ($FeTiO_3$), perofskite ($CaTiO_3$), titanite ($CaTiSiO_5$), and leucoxene. The last is an alteration product similar to titanite in chemical composition. Rutile is the principal ore mineral.

Rutile occurs both as a primary and secondary mineral. The source of the titanium was the magma that formed the igneous rocks of the cove.

The rutile deposits in Magnet Cove occur as placers and as disseminated deposits and fracture fillings in igneous rocks and metamorphosed sedimentaries. The rutile crystals have frequently been weathered from rocks in place, forming residual deposits, or have been transported to form stream deposits. The operations of the Titanium Corporation of America were confined to a deposit which was a combination of the two types of placers. The thickness of the deposit ranged from 6 inches to 8 feet, but a thickness of as much as 20 feet has been reported.

The present operations are in a disseminated ore body. The material in which the rutile occurs has undergone much alteration, some of which is due to weathering. The texture is similar to that of an altered tuff. The average thickness of the weathered zone is 12 feet. It consists of a mixture of clay minerals in which ribs of feldspar and irregular masses of calcite and pyroxene occur. The color is yellowish green, with occasional patches of creamy white. Rutile is irregularly disseminated throughout the material and also fills reticulated fissures. Relatively less-altered masses of dark greenish to black rock occur in the ore body.

These masses contain no disseminated rutile, but have occasional fracture fillings. They trend approximately N. 70° E. and are between 12 and 35 feet in width.

The Perkins ore body covers an area roughly 1,500 feet by 375 feet and has been prospected to a depth of 140 feet. The first 30 feet in dept has been explored by pits and trenches, the remainder by drill holes. Extending to the south and west a continuation of this ore body has been explored for 3,500 feet in length and 250 feet in width by trenching.

Following a recent study of the workings and adjacent explored area, Lacy [3] has arrived at the following conclusions regarding the structure and origin of the ore body.

1. The Structure of the cove is due to cauldron subsidence.
2. Gravity faulting caused by shrinkage of the cooling magma formed channels.
3. Along these channels escaping mineralizing solutions arose and subsequently formed the ore deposit.
4. The ore body appears to be localized along a zone of echelon fault which follows an arcuate pattern parallel to the cove rim.
5. The ore seems to be confined to the footwall on the north side of the fault zone.
6. On geologic inference, the ore deposit may be presumed to reach over 1,000 feet in depth.

CHARACTER OF ORE

Rutile is found in small drusy lumps and masses, or as solid fissure fillings. It sometimes has the form of geniculated twins. Paramorphs aft brookite occur as individual crystals. The unaltered rutile is steel bla but 30 percent of the concentrate shows a red color. Run-of-mine ore contains an average of 3 percent rutile and 4 percent total TiO_2.

The chief impurities are clay, silica, quartz, feldspar, calcite, apatite, pyrite, hematite, magnetite, and limonite, with traces of ilmenit ochtahedrite, titanite, and leucoxene. The silica occurs in the form of novaculite. There is very little quartz as druse fillings. Large and smal pyrite crystals occur throughout the ore body with the rutile. The ore is complex, and concentration is difficult. Since part of the titanium prese is within the lattice structure of the magnetite or in the altered product leucoxene, only a small portion is recoverable.

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[3] Lacy, Willard C., Progress Report of the Geology of the Perkins Ore Body, Magnet Cove, Arkansas, Unpublished report for the Titanium Allo Co. of Arkansas, September 1943, 7 pp.

A spectographic analysis of the ore for substances other than titanium and iron made for the Titanium Alloy Co. showed the presence of the following:

	Percent		Percent
Al_2O_3	17.0	V_2O_5	0.25
Na_2O	.8	CuO	.12
CaO	3.0	SnO	.005
K_2O	6.0	Cr_2O_3	.005
MgO	2.0	Ni_2O_3	.04
MnO_2	.4	BaO	.06

DEVELOPMENTS

The mine workings consist of a roughly elliptical pit about 1 500 feet long in an east-west direction and 375 feet wide in a north-south direction. The surface material has been stripped by previous operations, and the average depth of the pit is now 15 feet.

The altered rocks exposed are mostly soft and can be mined with a scraper. Occasional hard ribs are blasted. The character of the rock changes with depth, and more hard ribs which require blasting will be encountered as the pit floor is lowered.

Several faults are exposed in the pit. Lacy [4] states that they strike from N. 45° E. to N. 60° E. an dip between 75° and 85° S. E. The amount of throw appears to be small.

Following heavy rains, considerable water accumulates, which is drawn off the workings by cuts draining into Cove Creek. The depth of the water table is about 7 feet below the present level of the pit, or 22 feet below the former surface level.

PRESENT OPERATIONS

Mining

Mining operations are carried on in the pit with a Diesel tractor and carry-all scraper. The scraper carries the ore directly to the log washer, or to a stock pile from which a slackline cableway excavator conveys its to the crusher at the edge of the pit. The excavator is held for emergency use in wet weather when the pit floor is too slippery for the carry-all to operate.

Milling

Milling is carried out in three stages, as shown on the flow sheet (fig. 1). In the first, the ore is crushed and ground, and a concentrate that contains the titanium and other heavy minerals is produced by gravity methods.

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[4] Lacy, Willard C., Work cited on p. 4.

In the second stage, flotation eliminates a part of the impurities remaining in the concentrate from the first stage.

In the third stage, the flotation concentrate is jigged and tabled and the combined concentrate roasted and then run through an electrostatic separator, the tailing from which is sent to a stock pile for possible futur treatment. The concentrate is treated by a magnetic separator, from which a clean product for shipping is made. This is packed in 100-pound bags. The middling is returned to the electrostatic separator, another product goes to a stock pile for possible future treatment, and two tailing products go to waste.

Water for the plant comes from a pump station on the Ouachita River, which, aided by two booster pumps, delivers 600 gallons a minute through a 17,000-foot, 6-inch pipe line.

Chemical analyses are made at the plant for TiO_2, Fe, S, P_2O_5, and SiO_2 to maintain control of the concentrate.

Analyses of the mill product and rejected portion, from samples taken by the Bureau of Mines, are given below.

Analysis, percent

Material	Titania	Iron
Jig tailing	2.51	11.00
Pyrite concentrate (flotation)	13.00	41.00
Magnetic rejected portion	56.36	26.70
Rutile concentrate	95.02	2.40

Disposal of Product

The entire production of rutile concentrate is shipped to the Titanium Alloy Manufacturing Co. at Niagara Falls. It is used in the manufacture of welding rods, smoke-screen chemicals, and alloys.

CONCLUSION

The operation of the Titanium Alloy Co. of Arkansas has been too short to supply data on efficiency. The company anticipated reaching a production of 150 tons of rutile concentrate a month by the end of 1943. There appears to be an ample ore reserve, and every effort is being made to put the plant in good operating condition.

SUPPLEMENTARY NOTE

After the above article was prepared (Spring 1944) the operation was closed down. High losses of titanium in the tailing continued to be a problem and apparently require more intensive study of the mineralogy of the ore and alteration of the milling scheme.

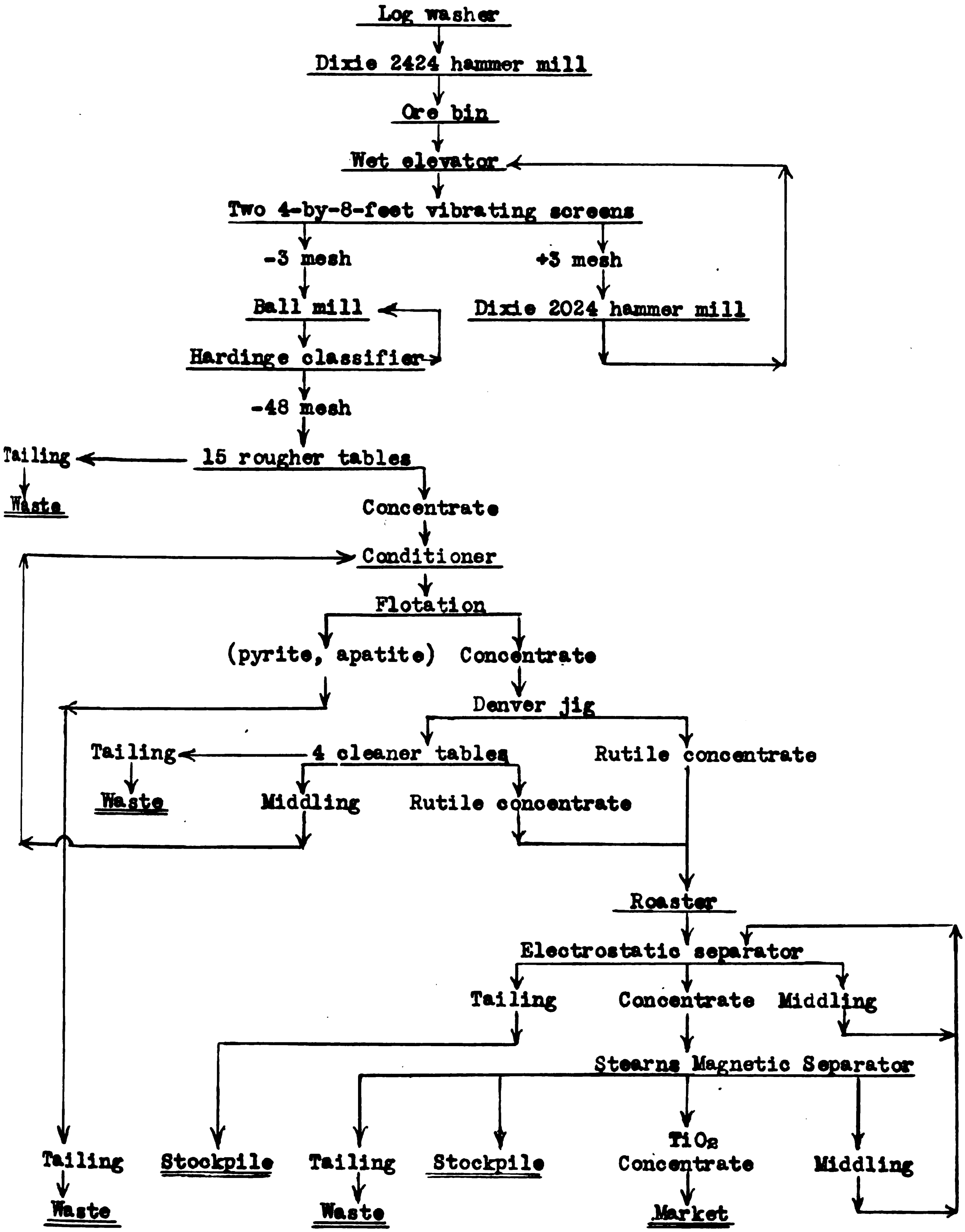

FIGURE 1.- Flow sheet, Titanium Alloy Co. of Arkansas, Malvern, Ark.

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